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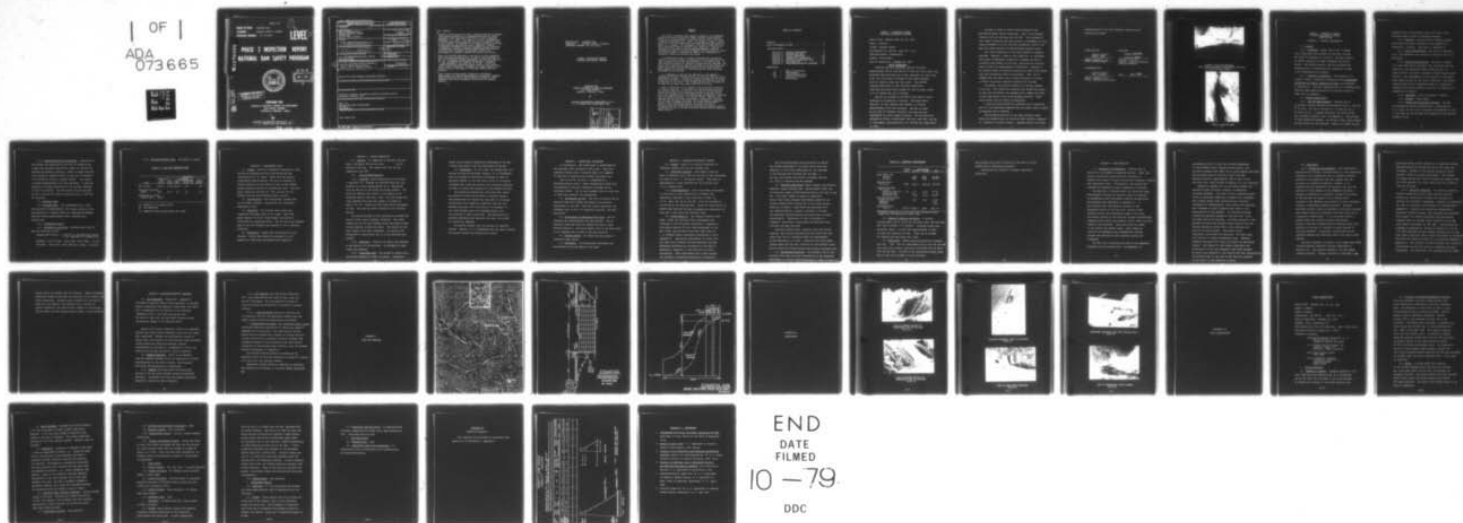
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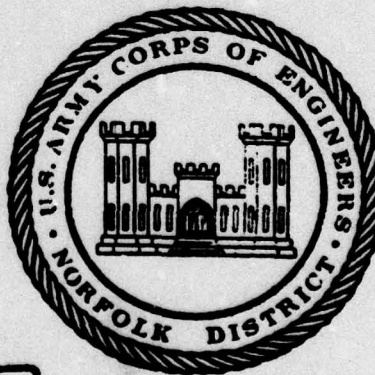
Name Of Dam: STAUNTON DAM
Location: AUGUSTA COUNTY, VIRGINIA
Inventory Number: VA. NO. 01518

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PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM



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PREPARED FOR
NORFOLK DISTRICT CORPS OF ENGINEERS
803 FRONT STREET
NORFOLK, VIRGINIA 23510

BY

SCHNABEL ENGINEERING ASSOCIATES, P.C./
J. K. TIMMONS AND ASSOCIATES, INC.

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20. Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam and appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

NAME OF DAM: STAUNTON DAM
LOCATION: AUGUSTA COUNTY, VIRGINIA
INVENTORY NUMBER: VA. NO. 1518

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED FOR
NORFOLK DISTRICT CORPS OF ENGINEERS
803 FRONT STREET
NORFOLK, VIRGINIA 23510

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J. K. TIMMONS AND ASSOCIATES, INC.

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the design flood should not be interpreted as necessarily posing a highly inadequate condition. The design flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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PHASE I - INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Staunton Dam, Va. No. 1518

State: Virginia

County: Augusta County

Coordinates: Lat 38°-20' Long 79° - 12.1'

USGS Quad Sheet: Stokesville

Stream: North River

Date of Inspection: December 13, 1978

BRIEF ASSESSMENT

Staunton Dam is a concrete, gravity structure approximately 266 ft long and 46 ft high (El 1924.5 MSL). The principal Ogee spillway has a crest elevation of 1919.0 MSL. A 36" cast iron pipe is located in the north abutment which is used to lower the lake level. The maximum reported flood flow at the structure occurred in 1949 when the water level reached El 1926.7+ (MSL), which is 2.2 ft above the top of the dam.

The dam is located on the North River about 6 miles southwest of Stokesville, Virginia. The Upper North River No. 76 Dam, Elkhorn Lake Complex, is located approximately 9,000 feet upstream. The dam is owned by the City of Staunton, Virginia, and they use the impoundment for water supply purposes. The structure was designed by Fuller & McClintock, New York, New York, and Lee H. Williamson, Charlottesville, Va. The dam was constructed in 1925.

The dam is rated as "High" hazard because of the downstream Forest Service dwellings. Such a risk category requires that the spillway pass the PMF. Data included in this report indicates that the spillway is inadequate in this regard although it is not seriously inadequate since it can pass more than one-half the PMF, (Probable Maximum Fluid).

The visual inspection of the dam revealed no apparent problems. However, a check of the stability in accordance with Corps of Engineers' guidelines, assuming the dam is founded on the surface of the rock, indicates the structure does not meet the requirements of Reference 1, Appendix V. An accurate check on stability could not be made since design data and calculations were not available. Thus, we recommend that the owner have a study performed to evaluate in detail the actual stability condition of the dam.

In general, the overall condition of the dam appears to be fair. The surface of structure was sealed with gunite in 1971 and the surface was sounded with a hammer and found to have some voids in the north abutment section. These voids should also be further investigated.

A warning system should be installed and an evacuation plan for the downstream camping area and ranger station should be prepared and be enforced.

The downstream portion of the right abutment slope which was eroded during the flood of 1949 should be replaced to conform to original contour. Seepage noted on the down-

stream portion of the left abutment should also be monitored quarterly.

Submitted By:

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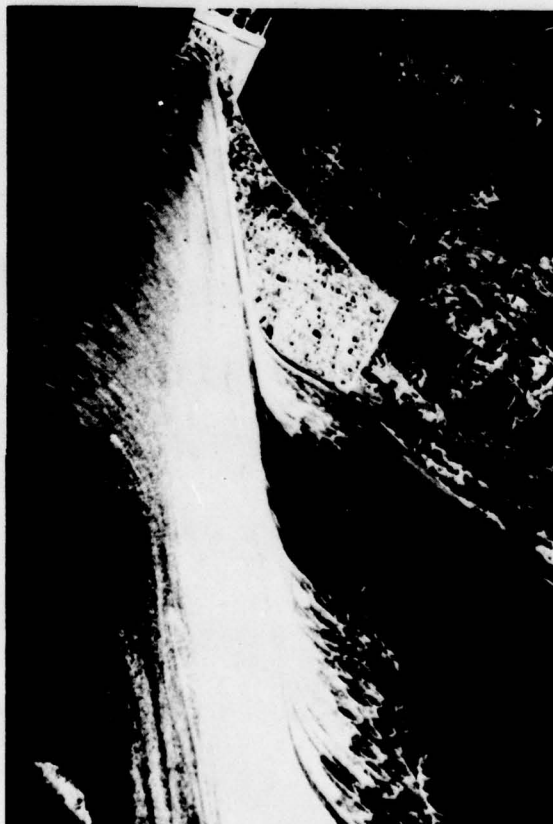
Original signed by
ZANE M. GOODWIN

Zane M. Goodwin, P.E.
Chief, Engineering Division

Date: MAR 15 1979



OVERALL VIEW FROM UPSTREAM
(NOTE ARROW INDICATING APPROXIMATE LOCATION
of 1949 Highwater Mark)



VIEW OF OGEE SPILLWAY

PHASE I - INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
STAUNTON DAM

SECTION 1 - PROJECT INFORMATION

1.1 General:

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of safety inspection of dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (see Reference 1, Appendix V). The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Project Description:

1.2.1 Dam and Appurtenances: Staunton Dam is a concrete, gravity structure approximately 266 ft. long and 46 ft high. The top of the dam is 7 ft wide and is at El 1924.5 M.S.L. A typical elevation and cross section are included on Sheets 2 and 3 of Appendix I. The spillway is Ogee shaped and ungated. As the pool rises, water automatically flows over the spillway. There is a valved 36 inch

diameter inlet at the bottom of the left side of the spillway which is used for drawdown purposes.

1.2.2 Location: Staunton Dam is located on North River about six miles southwest of the community of Stokesville, Virginia. (See Sheet 1, Appendix I)

1.2.3 Size Classification: The dam is classified as an "Intermediate" size structure because of the 46 ft dam height.

1.2.4 Hazard Classification: The dam is located in a rural and heavily forested area, and based upon the location of the downstream cabins owned by the U. S. Forest Service, the dam is assigned a "High" hazard classification. The impoundment is also used as the principal water supply source for the City of Staunton. The hazard classification used to categorize dams is a function of location only and has nothing to do with its stability or probability of failure.

1.2.5 Ownership: City of Staunton, Virginia

1.2.6 Purpose: Water Supply

1.2.7 Design and Construction History: The dam was designed by Fuller and McClintock, constructed by P. G. Ligon for the City of Staunton and completed in 1925. A "Guniting" of the spillway was completed on the exterior surface in 1971.

1.2.8 Normal Operational Procedures: Operations of the project are supervised by the City of Staunton and a part-time caretaker makes daily checks at the dam and performs maintenance functions. Water is piped from this site through an aqueduct tunnel to the City of Staunton. A 16" waterline, which is located inside the tunnel, is valved approximately 150' below spillway. A chlorine building is located downstream of the spillway adjacent to the 16" waterline. The gate house atop the spillway is not in use and the valves inside are open to feed the 16" waterline.

1.3 Pertinent Data:

1.3.1 Drainage Area: The impoundment has a total drainage area of approximately 28.9 square miles, of this, approximately 27.1 square miles are tributary to Elkhorn Lake Dam, located approximately 9000' upstream from Staunton Dam.

1.3.2 Discharge at Site:

1.3.3 Discharge at Dam Site: Maximum known flood at dam site occurred in 1949.

Maximum Known Flood: 11,100 CFS in 1949 (Measured approx. 3 mi. upstream at a gaging sta.)

Aqueduct (1-16" Outlet): (Pool Elev. 1924.5 MSL) - 42 CFS

Spillway: (Pool Elev. 1924.5 MSL, Top of Dam) - 6700 CFS

1.3.4 Dam and Reservoir Data: See Table 1.1 below.

Table 1.1 DAM AND RESERVOIR DATA

Item	Elevation feet M.S.L.	Reservoir			
		Area Acres	Capacity		Length Miles
			Acre Feet	Watershed Inches (a)	
Top of Dam	1924.5	45.42	210 (c)	2.2	.60
Principal Spillway Crest	1919	30.4	(b)	(b)	.57
Streambed at Center- line of Dam	1878.5				

(a) Based on 1.79 square miles.

(b) Not Measured.

(c) Measured from spillway crest (El 1919).

SECTION 2 - ENGINEERING DATA

2.1 Design: The only information available is that the dam was designed by Fuller and McClintock and constructed by P. G. Ligon. Other than the general construction specifications, the City of Staunton no longer possesses nor has record of any of the related design contract drawings or construction data. The last major inspection was June 25, 1970, by the City of Staunton and the United States Forest Service.

2.2 Construction: The construction records were not available, however, construction was reportedly completed in 1925.

2.3 Operation: The original gate valves are inoperable and remain open at all times. The inlet pipes connect to the 16" water supply line which is controlled by a motorized valve. The 36" cast iron drawdown pipe in the left abutment was reported to be in operable condition.

2.4 Evaluation: Design data and records are non-existent. Design data should be obtained if at all possible to facilitate maintenance and inspection.

SECTION 3 - VISUAL INSPECTION

3.1 General: An inspection of Staunton Dam was made 13 December 1978, and the pool was at Elevation 1919 MSL. The weather was fair and the temperature was 35°F.

3.2 Dam and Appurtenances:

3.2.1 Findings: Field Observations are outlined in Appendix III. Seepage was observed along the left abutment at a point approximately 20 ft downstream from the dam and 10 ft+ above the stream channel. The water was seeping from joints in the bedrock at an estimated rate of less than 1 gpm. The fill behind the right abutment wing wall was eroded to a depth of about 4 to 5 ft during the 1949 flood which overtopped the dam. The area was never restored to its original contour.

The gunited surface of the spillway was sounded and found to have voids in several locations. The valve chamber for the 36 inch drawdown inlet was found to have calcium deposits coating the walls. The valves for the water supply inlet were inoperable. It could not be determined if construction joints in the spillway were leaking.

3.2.2 Reservoir: Little or no debris was observed on the banks or at the spillway. No sloughing of bank slopes was observed.

3.2.3 Downstream Area: The stream is stable with a rock bottom showing no signs of erosion. Vegetation

exists in the channel immediately downstream of the dam.
A beaver dam exists 1,000 ft+ downstream of the dam.

3.3 Evaluation: At this time, the seepage does not present any serious problems, however, it is recommended that the seepage be continually monitored in order to determine whether or not the rate of flow is increasing. Increased flow rates may require that corrective measures be taken to insure the integrity of the abutment and dam.

The eroded area behind the right wing wall should be cleared of brush and refilled to original contour. This downstream fill behind the wing wall is of greater significance with respect to stability than the left abutment wing wall fill area since it is probable that the right abutment had to be embedded deeper into the hillside to reach sound rock. The downstream fill provides additional end restraint and thus, the eroded fill should be replaced.

The gunited surface does not present an immediate problem. However, it is recommended that the owner evaluate the gunited surface and construction joints.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: The normal pool is established at the spillway crest (Elevation 1919.0 MSL). This pool elevation allows water to gravity feed a 16" aqueduct to the City of Staunton filter plant for public use.

Flow in the 16" aqueduct is regulated by a motorized control valve. Water automatically flows over the spillway as the pool elevation increases due to increased inflow. The 36 inch drawdown inlet is used only to lower the reservoir for maintenance.

4.2 Maintenance of Dam: The City of Staunton has an operator make daily checks and perform the necessary maintenance of the dam. From the visual inspection, the equipment that is still in operating condition has been maintained.

4.3 Maintenance of Operating Facilities: The 36" drawdown gate appurtenances are kept greased. The 16" waterline motorized valve is checked and kept in good working condition. The water supply inlet at the gate house is not operable and is kept in the open position.

4.4 Warning System: No formal warning system or evacuation plan exists.

4.5 Evaluation: The operational procedures and maintenance of the dam appear to be good.

SECTION 5 - HYDRAULIC/HYDROLOGIC DESIGN

5.1 Design: There is no original hydraulic or hydrologic design data for the Staunton Dam.

5.2 Hydrologic Records: Gage Number 16205 has been in operation since 1947 and records of peak discharges are kept by the U. S. Geological Survey. This gage is approximately 3 miles upstream and the drainage area is 17.2 square miles.

5.3 Flood Experience: High water marks established in 1949 prior to the construction of Elkhorn Dam reportedly indicated a lake elevation of 1926.7 or 2.2 ft above the top of the dam. This was recorded as 11,100 cfs on the upstream gage. Since the construction of Elkhorn Dam upstream, the pool elevation has reportedly not been over 2 feet above the spillway crest.

5.4 Flood Potential: The Probable Maximum Flood (PMF), $\frac{1}{2}$ -PMF, and 100-year Flood hydrographs were developed by the SCS method (Reference 4, Appendix V). Precipitation amounts for the flood hydrographs of the PMF, $\frac{1}{2}$ -PMF, and 100-year Flood were taken from the U. S. Weather Bureau information (References 5 and 6, Appendix V). Appropriate adjustments for basin size and shape were accounted for, and emergency spillway hydrograph determination procedures as outlined in Reference 5, Appendix V, were used for the flood hydrographs. These hydrographs were routed through the spillway to determine maximum pool elevations.

The flood hydrographs were determined by adding the outflow hydrograph of the Upper North River Dam (Elkhorn) to the inflow hydrograph for the remainder of the drainage basin between the two dams. A one hour lag between the outflow of Elkhorn Dam and the inflow of Staunton Dam was assumed.

5.5 Reservoir Regulation: Water releases from Elkhorn Reservoir supply Staunton Dam. During normal flows, the 16-inch water supply intake utilizes most of the flow to the Dam. This water supply is always in operation. During flood flows, releases from Elkhorn Reservoir are greatly reduced below inflows due to the large storage capacity of Elkhorn. Flood flows are minimized up to the $\frac{1}{2}$ -PMF, after which, release at Elkhorn is through the emergency spillway whereby discharge rates increase significantly. Regulation of flow at Staunton is automatic, since water rising above the spillway crest overflows the Ogee spillway.

Spillway rating curves, reservoir area and storage capacity, and routing determinations were made from data taken from U.S.G.S. Quadrangle maps and measurements of the dam made at the site. Routing of the flood hydrographs began with the pool elevation at the spillway crest, and the flood was routed through the principal spillway only.

5.6 Overtopping Potential: The probable rise in the reservoir and other pertinent information on the reservoir performance in various flood hydrographs is shown on Table 5.1.

Table 5.1 RESERVOIR PERFORMANCE

	Normal Flow	Hydrograph 100-Yr	$\frac{1}{2}$ PMF	PMF
Peak flow, CFS				
Inflow		1590	5964	36,322
Outflow		1432	5983	34,939
Maximum Elev., ft M.S.L.	1919	1921.1	1924.44	1933.43
Ungated Spillway (EI 1919)				
Depth of flow, ft	.10	2.1	5.44	14.43
Duration, hrs		2	2	2
Velocity, FPS		5.64	9.09	14.81
Non-Overflow Section				
Depth of Flow		N/A	N/A	8.93
Duration				2.0
Velocity				7.75
Tailwater Elev., M.S.L.	1878.5*	1883.5	1889	1912.70

*Tailwater elevation is that which was observed during inspection and represents normal flow.

5.7 Reservoir Emptying Potential: A 36-inch circular gate, 40 ft below the spillway crest, (EI 1879 MSL) will drain through a 36" aqueduct. Assuming normal pool elevation (1919), it would take approximately 10 days to lower the reservoir 40 feet. There are no methods of lowering the lake below this level.

5.8 Evaluation: Flood routing calculations indicate that the dam will be overtopped by 8.93 feet for the PMF. This depth will create a velocity of 14.81 fps for two hours over the spillway. The PMF is the appropriate design flood due to high risk assigned to this structure.

The spillway will pass 50 percent of the PMF as long as Elkhorn Dam is functioning properly,

Conclusions are relative to present hydrologic conditions.

SECTION 6 - DAM STABILITY

6.1 Foundation and Abutments: Staunton Dam is believed to be founded on sandstone bedrock. Other than general construction specifications, the City of Staunton was unable to locate the contract drawings or design and construction data. Consequently, only generalized information obtained by visual inspection is reported.

The dam site is located within the Valley and Ridge Physiographic Province of Virginia, which is underlain by sedimentary rocks from Middle Cambrian through Early Mississippian age (Reference 3, Appendix V). In the Staunton area, the province consists of the Shenandoah Valley to the east and a series of much narrower valleys and intervening ridges to the west. The eastern portion of the province includes southeastward-dipping thrust faults and asymmetric folds, which are overturned to the northwest. More open folds are common in the central and western areas. Most ridges are "held up" by sandstones and conglomerates, whereas valleys are underlain by less resistant shales and limestones.

The dam site is underlain by rocks of the Hampshire formation of Late Devonian age. The Hampshire is

approximately 2200 ft thick and includes moderately to thick-bedded, brown, medium-grained, arkosic and micaceous sandstone, and lumpy red to green mudrock and shale. The structure rests on the west limb of the West Mountain Syncline, approximately 1000 ft west of the synclinal axis, which strikes 40 degrees \pm to the northeast.

Bedrock is exposed only in the north abutment and consists of gray to brown, slightly to moderately weathered sandstone. The rock is fine to medium-grained, thinly to massively bedded and includes local crossbeds. The outcrops exhibit some fracturing and a distinct rectangular to subrectangular joint pattern was observed. Thin interbeds of shaly sandstone were noted in the upper portion of the abutment. An isolated sandstone outcrop was partially exposed in the wing wall, along the south end of the spillway. Attitudes measured in the abutment and along the adjacent slope indicate that the bedrock generally strikes 35° \pm to the northwest and dips 5° \pm to the northeast. The joints strike essentially north-south and east-west. The dips range from vertical to steep northwesterly dips. Numerous sandstone outcrops occur along and within the downstream channel. The bedrock is very similar physically and structurally to the rock exposed in the north abutment. No faults were observed in the field during this investigation and geologic maps of the area do not show the presence of any faults in the immediate vicinity.

6.2 Evaluation:

6.2.1 Foundation and Abutments: The construction specifications include a section related to rock excavation, therefore, it is assumed the dam is founded on bedrock. Outcrops in the immediate area also suggest that the structure is founded on sandstone, however, it is possible that the foundation may actually rest upon the mudstone or shale members of the Hampshire Formation. Assuming a foundation on sandstone, excessive settlement of the dam does not appear to be a problem since outcrops in the immediate area consist of fairly competent, slightly to moderately weathered bedrock. Measured attitudes indicate there are probably no adversely oriented weak planes within the foundation rock that would act as a potential sliding plane. It is not known whether a cutoff trench was installed during construction, however, only minor seepage would be expected along joint patterns in the rock, if similar to those observed in the north abutment. Furthermore, piping would not be expected assuming the underlying rock is the same as that exposed.

The north abutment intersects a very steep slope which includes numerous sandstone outcrops (described in Section 6.1). The abutment appears to tie into sound sandstone bedrock. Seepage estimated at less than 1 gpm

was noted along a joint surface in a sandstone outcrop approximately 20 ft downstream and 10 ft+ above the streambed. Bedrock is not exposed along the south abutment, which is graded and grassed. The absence of seepage during the field investigation suggests that the south abutment ties into sound rock some distance into the hillside.

6.2.2 Stability Analysis: An accurate stability analysis could not be made since neither contract drawings nor construction records are available to indicate the foundation embedment. However, an evaluation was made in accordance with Section 4.4 of Reference 1, Appendix V. Assuming the structure resting upon a horizontal bedrock surface, the stability was evaluated with respect to sliding resistance and overturning assuming water at the dam crest, and 14.4 ft over the crest which corresponds to the PMF. Calculations are included in Appendix IV. Factors of safety of 1.35 and 1.32 were obtained for the sliding condition for the two pool level conditions. These factors of safety are substantially less than the factor of safety of 3 required by Reference 1, Appendix V. The stability of the structure with respect to overturning for the two reservoir conditions was also determined. At normal pool, the resultant of all forces

passes within the middle third of the base. Under surcharged conditions caused by the PMF, the resultant of all forces will cause overturning. Without direct evidence that the dam is keyed into the bedrock, and assuming only a surface of bedrock foundation, the dam would be subject to overturning failure under the PMF loading without regard to end restraint.

SECTION 7 ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment: Reference I, Appendix V, recommends a Spillway Design Flood equivalent to the PMF. Based on hydrologic and hydraulic evaluations, the spillway is inadequate for the PMF but is not seriously inadequate since it can pass the one-half PMF. The PMF will pass over the dam itself causing erosion and possible damage to the chlorine house.

Based on the visual inspection, there is no apparent problem that would require immediate action for the normal pool conditions. Without the construction records or design data, the stability of the structure under designed loading conditions cannot be assessed, however, investigation by the owner is recommended to verify the stability of the dam and gunite surface condition.

7.2 Remedial Measures: There is no immediate need for remedial measures prior to completion of further investigations by the owner, however, the following monitoring and maintenance is recommended.

7.2.1 Seepage occurring within the downstream portion of the one north abutment should be monitored quarterly. Increased flow rates may require corrective measures to insure the dam's integrity.

7.2.2 The backfill area behind the south wind wall was eroded during the flood of 1949 when the dam was overtopped. The area should be cleared of brush and debris and backfilled to conform to original contours.

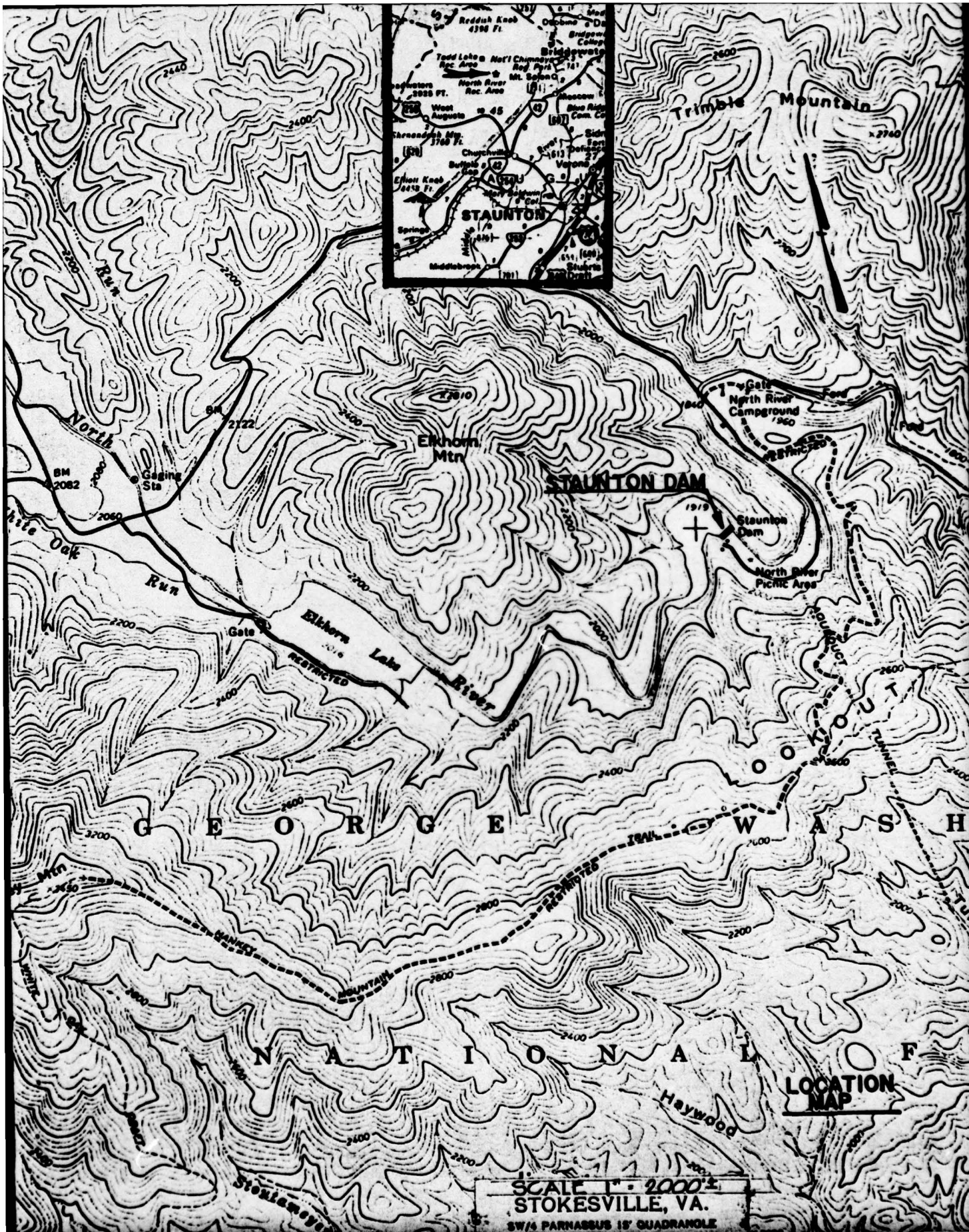
7.2.3 A warning system should be installed and an evacuation plan for the downstream camping area and ranger station should be prepared and be enforced.

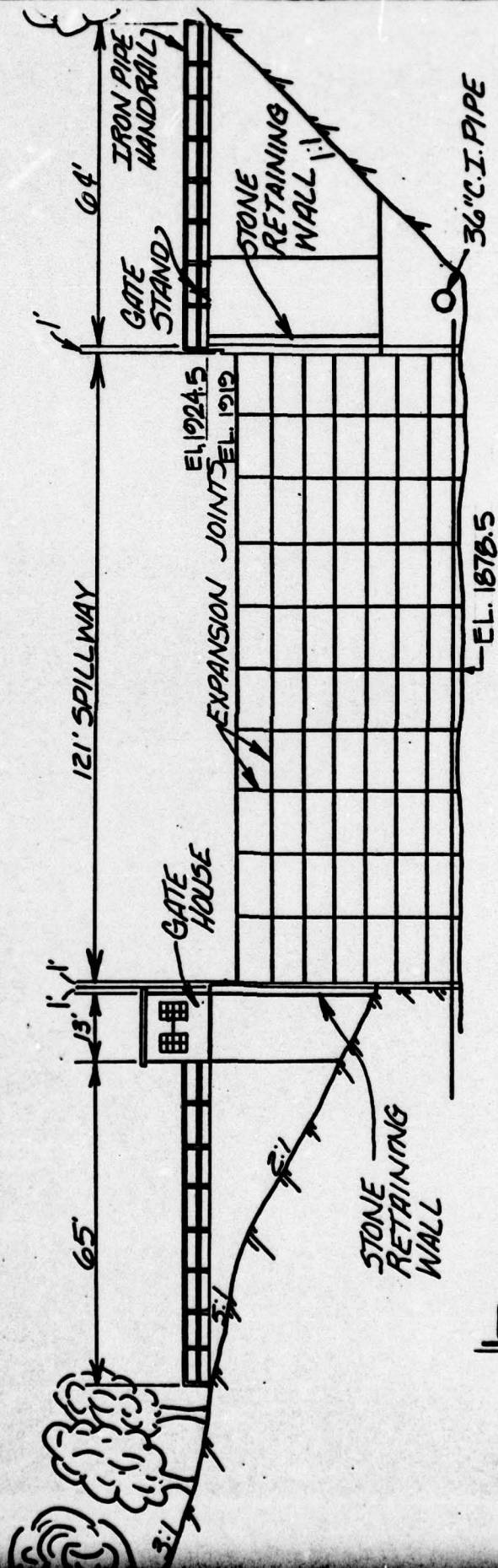
7.3 Investigation by Owner: This investigation should include sufficient subsurface exploration to define the depth of embedment of the structure. The stability of the dam should then be assessed with respect to sliding and overturning utilizing the estimated foundation geometry and estimated strength of the foundation rock and friction resistance of the concrete-rock interface using the methods defined in Reference I, Appendix V.

The gunited surfaces should be sounded and the expansion joints on spillway checked for leakage at a period of no flow over the spillway surface.

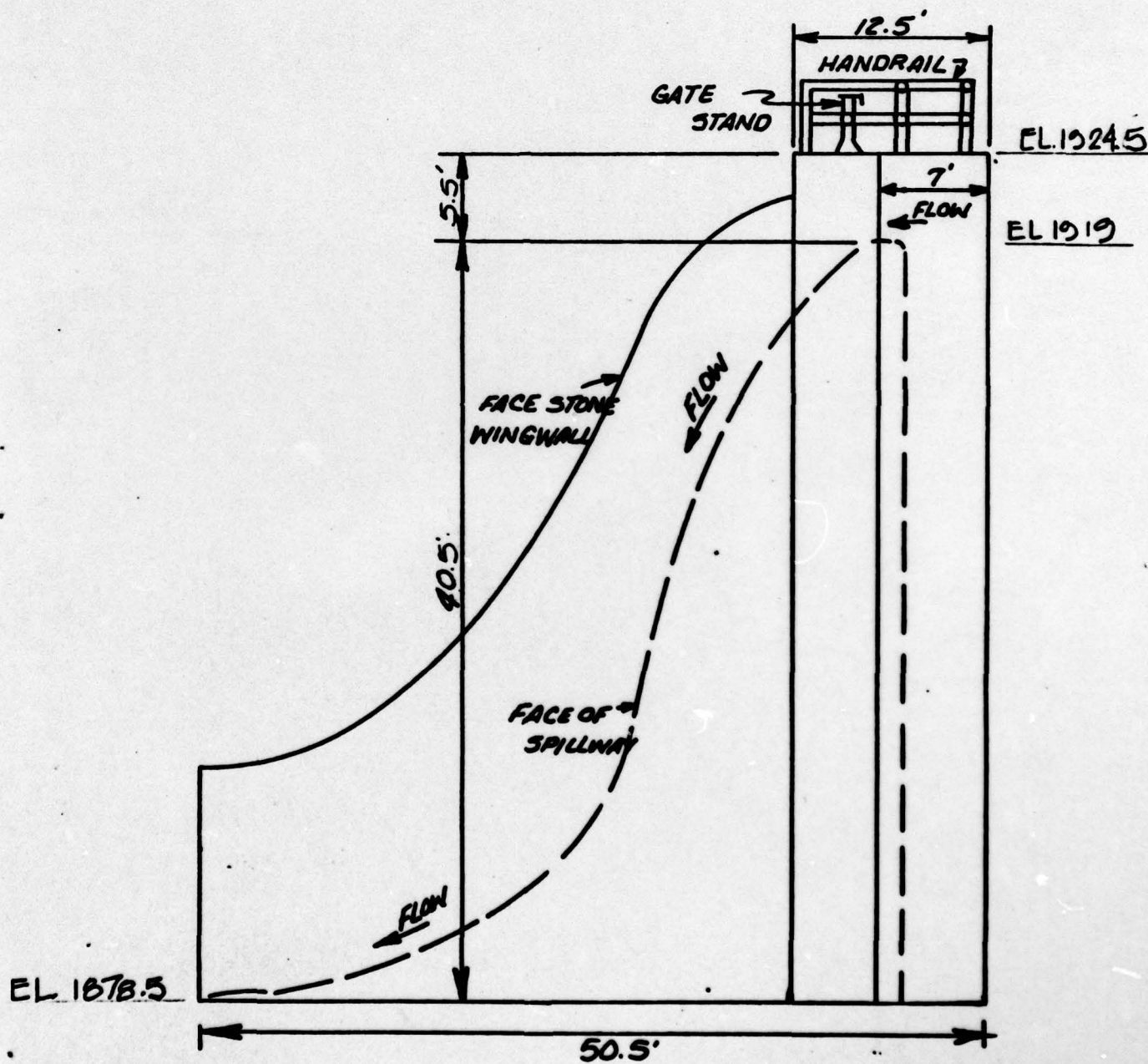
Additional studies should be completed to determine what measures are necessary to minimize damage during the PMF.

APPENDIX I
MAPS AND DRAWINGS





STAUNTON
RESERVOIR
ELEVATION
NO SCALE



STAUNTON DAM
BASIC SECTION OGEE SPILLWAY
 NO SCALE

APPENDIX II
PHOTOGRAPHS



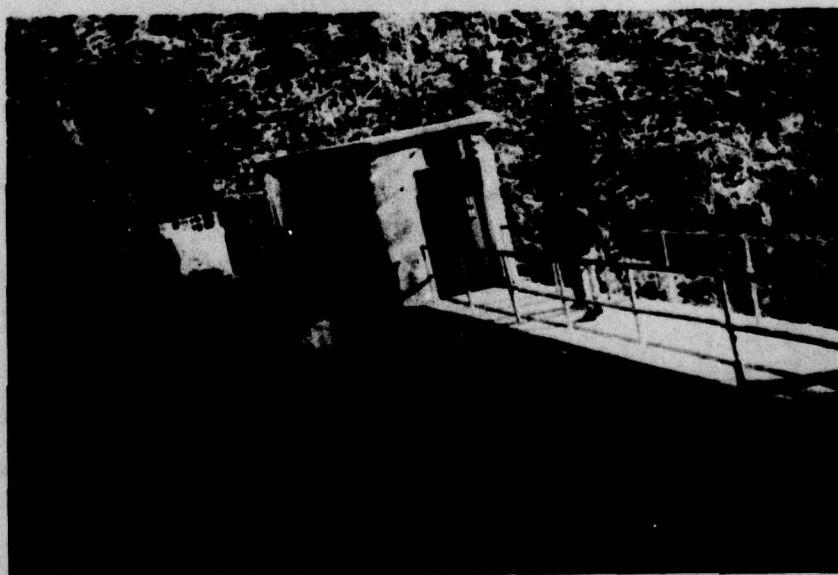
**VIEW OF WESTERN SECTION OF
DOWNSTREAM SIDE OF SPILLWAY
Photo #1**



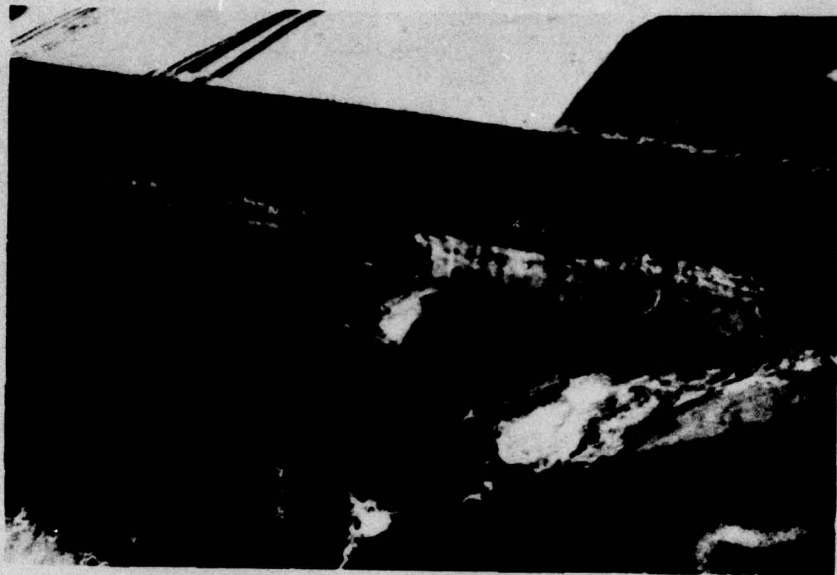
**VIEW OF EASTERN SECTION OF
DOWNSTREAM SIDE OF SPILLWAY
Photo #2**



CLOSE-UP EXPANSION JOINT ON SPILLWAY
Photo #3



VIEW OF GATE HOUSE STRUCTURE
Photo #4



DOWNSTREAM RETAINING WALL AND STILLING BASIN
Photo #5



VIEW OF DOWNSTREAM OUTLET CHANNEL
Photo #6

APPENDIX III
FIELD OBSERVATIONS

FIELD OBSERVATIONS

Name of Dam: Staunton Dam, Va. No. 1518

County: Augusta

State: Virginia

Coordinates: Lat 38°-20' Long 79° - 12.1'

Date of Inspection: December 13, 1978

Weather: Fair, temperature 35°

Pool Elevation at Time of Inspection: Elev. 1919.0 M.S.L.

Tailwater at Time of Inspection: 1880.0

Inspection Personnel:

Schanbel Engineering Associates, P. C.
Ray E. Martin, P. E.
Stephen G. Werner (recorder)

J. K. Timmons and Associates, Inc.
Robert G. Roop, P.E.
William A. Johns (recorder)

State Water Control Board
John Hyden

City of Staunton, Virginia
Jonathan P. Roper, P. E.
John McClintock
Robert Loyd

1 Concrete/Masonry:

1.1 Seepage or Leakage: Seepage estimated at less than 1 gpm was noted approximately 20 ft downstream and 10 ft+ above the streambed in the north abutment. No seepage was observed in the south abutment area.

1.2 Structure to Abutment/Embankment Junction:

The north abutment ties into a steep natural rock slope consisting of essentially horizontal sandstone beds. The sandstone is light brown to gray in color, fine-grained and thin to massively bedded. Bedrock appears fresh to moderately weathered. Bedding strikes $30^{\circ} \pm$ to the northwest and dips $5^{\circ} \pm$ to the northeast. The bedrock also possesses a rectangular (+) joint system and includes the following measured joint set: N87E, 90 and N3E, 75NW. Thin shaley interbeds occur near the catwalk level. No bedrock is exposed along the moderate slopes which form the south abutment. Overburden exposed in the south abutment consists of fill, colluvial and residual soils. The downstream portion of the abutment slope includes a washed out area, which developed during 1949 when the dam was overtopped. It includes some ruts and is overgrown with various types of vegetation.

1.3 Drains: A 3-inch drain exits adjacent to the 36-inch drawdown pipe along the north abutment. The 3-inch pipe drains the dry well and probably the abutment wing wall. The south abutment wing wall includes three 3-inch drains which drain seepage from behind the south wing wall. All drains were flowing clear at the time of inspection.

1.4 Water Passages: Passages are clear of debris. A 36" cast iron drain is used to lower lake and is operable. A 16" cast iron intake is used for water supply to the City of Staunton. No visible leaks were observed at the lower control station. Valves in dam not operable.

1.5 Foundation: Sandstone is exposed in the north abutment as described in Section 1.2. Along the south side of the spillway (south abutment) wing wall, a sandstone outcrop, partially covered with concrete, was observed. The bedding is essentially horizontal. Available geologic data indicates the dam rests upon the Hampshire Formation, i.e., shale, sandstone, and mudrock. Based on the sandstone outcrops observed downstream, in the north abutment and at the south abutment wing wall, the dam is probably founded on sandstone, however, this cannot be confirmed visually. The structure could be founded in part on shale.

1.6 Surface Cracks, Concrete Surfaces: Various surface cracks on spillway. Spillway was sealed with Gunitite in 1971, but appears to be bleeding lime from concrete. Observation by owner indicates no visible wet spots when water below spillway.

1.7 Structural Cracking: None observed.

1.8 Vertical and Horizontal Alignment: Good.

1.9 Monolith Joints: Fair condition.

1.10 Construction Joints: Unseen, surface covered with Gunite.

1.11 Erosion of Abutment Slopes: During the flood of 1949, when water overtopped the dam, the fill behind the south abutment wing wall was eroded to a depth of about 4 to 5 feet. This area was never restored to its original contour and presently contains a thick growth of underbrush.

2 Water Works:

2.1 Outlet Conduit: 36" cast iron. In good condition.

2.2 Intake Structure: No leakage, gates operable, ladder in good shape.

2.3 Outlet Structure: Stilling basin is depressed. Sinkholes occurred in stilling basin in past but were filled with concrete in 1971.

2.4 Outlet Channel: Good condition. No debris, some heavy shrubs.

2.5 Emergency Gate: None

3 Reservoir: In good condition, steep slopes, no debris noticed.

3.1 Slopes: Steep natural slopes with numerous sandstone outcrops bound most of the reservoir, particularly the north side. A small indentation

(40'± by 20'±) is visible near the dam, upstream from the north abutment. This may be an area cut into rock during the dam construction; possibly a small quarry. Slopes change from steep to moderately steep along the northwest side of the reservoir, before encountering a stream entering the west end of the lake. A local graded and disturbed area adjacent to the southwest end may represent a borrow area. Vertical slopes less than 15 ft± high occur along the southeast side and include scattered sandstone outcrops. A small, possible former slide area, was located along the southeast side of the reservoir. Trees in the scarp are vertical and mature. No unstable slopes were encountered during the investigation.

3.2 Sedimentation: None observed.

4 Downstream Channel:

4.1 Condition: A 3 ft± high beaver dam crosses the stream approximately 1000 ft downstream from the structure.

4.2 Slopes: Steep natural rock slopes bound the north side of the channel, while a wide floodplain bounds the south side. The floodplain is vegetated with trees and is blanketed with abundant gravel-to-boulder size debris. There was no observed evidence of slides.

4.3 Population and Facilities: An administrative building, campground and bridge exist approximately one mile downstream from the dam.

5 Instrumentation:

5.1 Monumentation: None

5.2 Observation Wells and Piezometers: No observation wells or piezometers were located during our field observations.

APPENDIX IV
STABILITY ANALYSIS

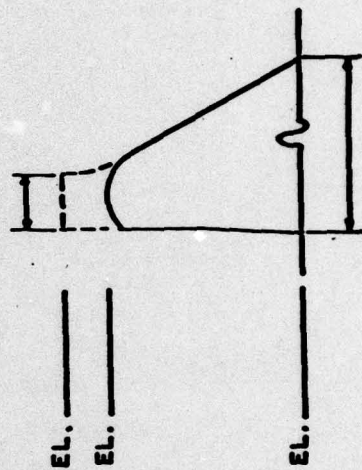
This analysis was performed in accordance with
Section 4.4 of Reference 1, Appendix V.

GRAVITY DAM DESIGN STABILITY ANALYSIS

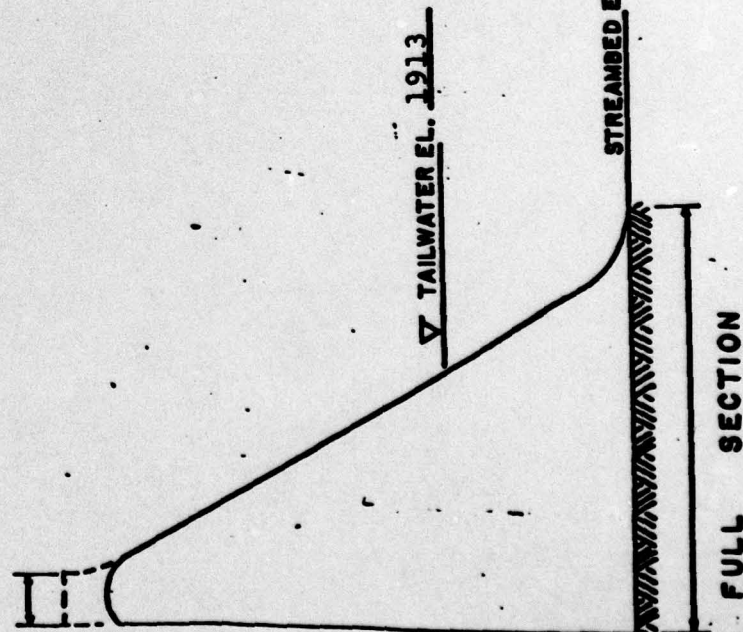
ANALYSIS DONE ON X FULL SECTION — PARTIAL SECTION
LOCATION OF SECTION CENTERLINE OF SPILLWAY

ANALYSIS PREPARED BY _____

LOADING CASE	ELEV. HEAD WATER	ELEV. TAIL WATER	ΣV	ΣH	$\frac{\Sigma H}{\Sigma V}$	LOCATION RESULTANT FROM TOE	% BASE IN COMPRESSION	FACTOR SAFETY SLIDING	FOUNDATION PRESSURE	
									TOE	HEEL
NORMAL POOL	1919	1878.5	49.3 K	55.0 K	1.11	15.6'	100%	1.35	4.11ksf	0.84 ksf
PROBABLE MAXIMUM FLOOD	1933.5	1913	33.3 k	47.5 k	1.42	4.1'	31%	1.32	5.4 ksf	0 ksf



PARTIAL SECTION



FULL SECTION

NOTE: ANALYSIS DOES NOT CONSIDER ABUTMENT END RESTRAINT.

N/A

BUILDING

N/A

STREAMBED EL. 1878.5

TAILWATER EL. 1913

1924.5

1919

APPENDIX V - REFERENCES

1. Recommended Guidelines for Safety Inspection of Dams, Department of Army, Office of the Chief of Engineers, 46 pp.
2. Design of Small Dams, U. S. Department of Interior, Bureau of Reclamation, 1974, 816 pp.
3. Geology of the Stokesville and Parnassus Quadrangles, Virginia, Reports of Investigations No. 19, E. K. Rader, Virginia Division of Mineral Resources, 1969, 30 pp.
4. Section 4, Hydrology, Part 1 Watershed Planning, SCS National Engineering Handbook, Soil Conservation Service, U. S. Department of Agriculture, 1964.
5. Hydrometeorological Report No. 33, U. S. Department of Commerce, Weather Bureau, U. S. Department of Army, Corps of Engineers, Washington, D. C., April, 1956.
6. Technical Paper No. 40, U. S. Department of Commerce, Weather Bureau, Washington, D. C., May 1961.